AFWAL-TR-80-4094

LEVEL II

AD A091945

MECHANICAL PROPERTY EVALUATION OF ALUMINUM ALLOY 7010-T73651

Russell R. Cervay

University of Dayton
Research Institute
Dayton, Ohio 45469

July 1980

DTIC
ELECTE
NOV 21 1980
S D
C

Technical Report AFWAL-TR-80-4094
Interim Technical Report for Period
November 1978 - March 1980

Approved for Public Release; Distribution Unlimited.

MATERIALS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORY
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

DDC FILE COPY

80 11 12 146

NOTICE

When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the government may have formulated, furnished, or in any way supplied the said drawings, specifications, or other data, is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

This report has been reviewed by the Office of Public Affairs (ASD/PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

David C Watson
DAVID C. WATSON
Engineering and Design Data
Materials Integrity Branch

Clayton Harmsworth
CLAYTON HARMSWORTH
Technical Manager
Engineering and Design Data
Materials Integrity Branch

FOR THE COMMANDER:

Thomas D. Cooper
THOMAS D. COOPER, Chief
Materials Integrity Branch
Systems Support Division
Air Force Materials Laboratory

"If your address has changed, if you wish to be removed from our mailing list, or if the addressee is no longer employed by your organization, please notify AFWAL/MLSA, W-PAFB, OH 45433 to help us maintain a current mailing list."

Copies of this report should not be returned unless return is required by security considerations, contractual obligations, or notice on a specific document.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: AFWAL-TR-80-4094	2. GOVT ACCESSION NO.: AD-A092 945
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): MECHANICAL PROPERTY EVALUATION OF ALUMINUM ALLOY 7010-T73651.	5. TYPE OF REPORT & PERIOD COVERED: Interim Technical Report, Nov [redacted] 1978-Mar [redacted] 80
	6. PERFORMING ORG. REPORT NUMBER: UDR-TR-80-29
7. AUTHOR(s): Russell R. Cervay	8. CONTRACT OR GRANT NUMBER(s): F33615-78-C-5002
9. PERFORMING ORGANIZATION NAME AND ADDRESS: University of Dayton Research Institute, 300 College Park Avenue, Dayton, Ohio 45469	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2421-03-05
11. CONTROLLING OFFICE NAME AND ADDRESS: Materials Laboratory/Air Force Wright Aeronautical Laboratories (AFWAL/MLSA), Wright-Patterson Air Force Base, Ohio 45433	12. REPORT DATE: Jul [redacted] 1980
	13. NUMBER OF PAGES: 21
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aluminum
7010-T73651
Tensile
Fracture toughness
Stress corrosion cracking
Cyclic loading crack growth

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The alloy 7010 has been represented by its manufacturer as being a high strength/high toughness, and stress corrosion cracking resistant aluminum alloy. Like the 7050 alloy, it is a high purity aluminum alloy using Zr as the grain refiner alloying element rather than Cr. Also, the Cu alloying content is higher than normal for most 7000 series aluminum alloys. next page

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

105400

(sq rt. in.) (sq. rt. m)

20. Abstract (Continued)

Tensile test results indicate the average room temperature tensile strength was 73 KSI (502 MPa) and the yield strength was 64 KSI (440 MPa) for longitudinal grain orientation test specimens. For the same test conditions, the ductility as indicated by an elongation of 13 percent (1 in., 25.4 mm G.L.) was directly comparable to alloy 7175-T73 in the thick plate product form. The average fracture toughness at 72°F (22°C) for a (L-T) orientation test specimen was 37 KSI√in (40.6 MPa√m) which is approximately equal to alloy 7050-T73651. The material was not found to be corrosion cracking sensitive; the room temperature threshold for stress corrosion cracking in a 3.5% Wt. NaCl solution was determined to be in excess of 70 percent of the room temperature fracture toughness. The materials room temperature constant amplitude fatigue crack growth rate was equivalent to the more cracking resistant 7000 series alloys (7475 and 7050). An increase in the test temperature from 72°F (22°C) to 250°F (121°C) caused an increase in excess of 200 percent in the fatigue crack growth rate. A further increase in test temperature to 350°F (176°C) caused a small increase in the crack growth rate beyond that existing at 250°F (121°C).

FOREWORD

This interim technical report was submitted by the University of Dayton Research Institute, Dayton, Ohio, under Contract F33615-78-C-5002, "Quick Reaction Evaluation of Materials," with the Materials Laboratory, Air Force Wright Aeronautical Laboratories, Wright-Patterson Air Force Base, Ohio. Mr. David Watson, AFWAL/MLSA was the Laboratory Project Monitor for this program.

This effort was conducted during the period of November 1978 through March 1980. The author, Mr. Russell R. Cervay, was responsible for the direction of the program and he would like to extend recognition to Messrs. D. Woleslagle, J. Eblin, and D. Opela for performing the physical testing in the laboratory.

The report was submitted by the author in May 1980.

TABLE OF CONTENTS

SECTION		PAGE
I	INTRODUCTION	1
II	MATERIAL	1
III	TEST PROGRAM	2
IV	TEST SPECIMENS	2
V	RESULTS AND DISCUSSION	6
VI	CONCLUSIONS	16
	REFERENCES	21

Accession For
NTIS GRA&I ☑
DTIC TAB ☐
Unannounced ☐
Justification

By
Distribution/
Availability Codes
Dist A | Avail and/or Special

PRECEDING PAGE BLANK-NOT FILMED

LIST OF ILLUSTRATIONS

FIGURE		PAGE
1	Specimen Configuration Used for Longitudinal and Long-Transverse Grain Orientation Tensile Tests	3
2	Specimen Configuration Used for Short-Transverse Grain Orientation Tensile Tests	4
3	Compact Type Specimen Configurations Used for Fracture Toughness (K_{IC}), Threshold for Stress Corrosion Cracking (K_{ISCC}), and Cyclic Loading Crack Growth (da/dN) Tests	5
4	Constant Amplitude Loading Cyclic Crack Growth Test Results for CT Specimens Loaded in the Longitudinal Grain Direction at 72°F (22°C)	10
5	Constant Amplitude Loading Cyclic Crack Growth Test Results for CT Specimens Loaded in the Long-Transverse Grain Direction at 72°F (22°C)	11
6	Constant Amplitude Loading Cyclic Crack Growth Test Results for L-T and T-L Oriented CT Specimens at 72°F (22°C)	12
7	Constant Amplitude Loading Cyclic Crack Growth Test Results Plotted Along with Room Temperature Aluminum Alloy 7050-T73 Test Data	14
8	Constant Amplitude Loading Cyclic Crack Growth Test Results Plotted Along with Reference Room Temperature Aluminum Alloys 7475-T7351 and 7010-T73 Test Data	15
9	Constant Amplitude Loading Cyclic Crack Growth Test Results for Longitudinal Grain Loaded CT Specimens at 250°F (121°C)	17
10	Constant Amplitude Loading Cyclic Crack Growth Test Results for Long-Transverse Grain Loaded CT Specimens at 250°F (121°C)	18
11	Constant Amplitude Loading Cyclic Crack Growth Test Results for L-T Oriented CT Specimens at 72°F (22°C), 250°F (121°C), and 350°F (176°C)	19

LIST OF TABLES

TABLE		PAGE
1	Tensile Properties of Al 7010-T73651	7
2	Fracture Toughness Test Results for Aluminum 7010-T73651	8

SECTION I
INTRODUCTION

Aluminum alloy 7010 was developed by Alcan Plate Limited, Birmingham, England. The material is of interest to the Air Force because it has been accepted by several European sources as being an equivalent substitute for alloy 7050 and proposed for use in the country. There is limited mechanical property test data available in the literature for the alloy 7010. Both alloys 7050 and 7010 were developed for applications requiring high strength, high fracture toughness, exfoliation resistance, and stress corrosion cracking resistance in thick section product forms, e.g., 2 to 4 inch (50.8 to 101.6 mm) thick rolled plate.

SECTION II
MATERIAL

Alcan Plate Limited produced the test material which they provided in the form of a 2 inch (50.8 mm) thick rolled plate. It was provided in the T73651, overaged and cold-worked heat treatment. The material is a high purity aluminum alloy with very small amounts of iron and silicon impurities present. The findings of a chemical constitutent analysis are presented below. The alloy's copper content is high for a 7000 series aluminum alloy and is intended to improve stress corrosion cracking resistance. Except for a slightly higher copper content, the two alloys, 7010 and 7050, are similar in chemical composition. Both alloys use zirconium rather than chromium as the grain refiner. Zirconium provides high strength and toughness while retaining a corrosion resistant property.

CHEMICAL COMPOSITION, WT. PERCENT

	Zn	Mg	Cu	Zr	Si	Fe	Ti	Mn	Cr	Other	Al
7010 Test Material	6.0	2.3	1.9	0.12	0.09	0.07	0.01	<0.01	<0.01	<0.01	Balance
Alcan 7010 Spec.	5.7-6.7	2.2-2.7	1.5-2.0	0.11-0.17	0.10 Max	0.15 Max	0.05 Max	0.03 Max	0.05 Max	0.05 0.15 tot.	Balance
7050 Mil Spec.	5.7-6.7	1.9-2.6	2.0-2.6	0.08-0.15	0.12 Max	0.15 Max	0.06 Max	0.10 Max	0.04 Max	0.05 0.15 tot.	Balance

SECTION III
TEST PROGRAM

Included in the test program are test data for the following mechanical properties: tensile strength, fracture toughness, stress corrosion cracking threshold in a 3.5 percent by weight NaCl solution, and constant amplitude fatigue crack growth rate. Duplicate tests were performed for the fracture toughness data at both 72°F (22°C) and 250°F (121°C). All tensile tests were conducted at 72°F (22°C). For the tensile and fracture toughness tests, duplicate specimens were machined from the plate with specimen loading directions parallel to each of the three principle grain orientation directions. Specimens for the fatigue crack growth tests were loaded in one of two principal grain directions, longitudinal and long-transverse, both at room temperature and 250°F (121°C). A single crack growth test was conducted at 350°F (176°C); this specimen had the L-T grain orientation. Only short transverse (S-L) loading direction specimens were used for the stress corrosion threshold tests.

All tests were conducted in compliance with the applicable ASTM testing procedure: E-399-78, "Plain Strain Fracture Toughness of Metallic Materials"; E-8-78, "Tension Testing of Metallic Materials"; and E-647-78T, "Constant-Load-Amplitude Fatigue Crack Growth Rate Above 10^{-8} m/cycle." Where test standards are nonexistent, as in the case of stress corrosion cracking, current practices employed throughout the technical community were used.

SECTION IV
TEST SPECIMENS

Figure 1 illustrates the specimen geometry used for determining tensile properties with the loading directions parallel to the longitudinal and long-transverse grain directions. The miniature specimen used for determining the through-the-thickness (short-transverse grain direction) tensile properties is presented in Figure 2. Figure 3 depicts the compact specimens (CT) employed for:

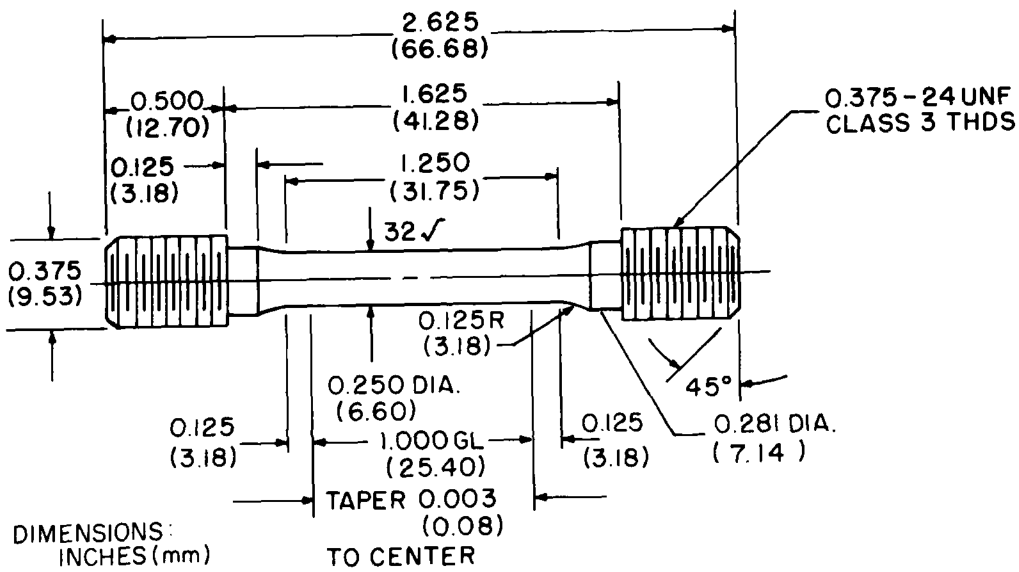


Figure 1. Specimen Configuration Used for Longitudinal and Long-Transverse Grain Orientation Tensile Tests.

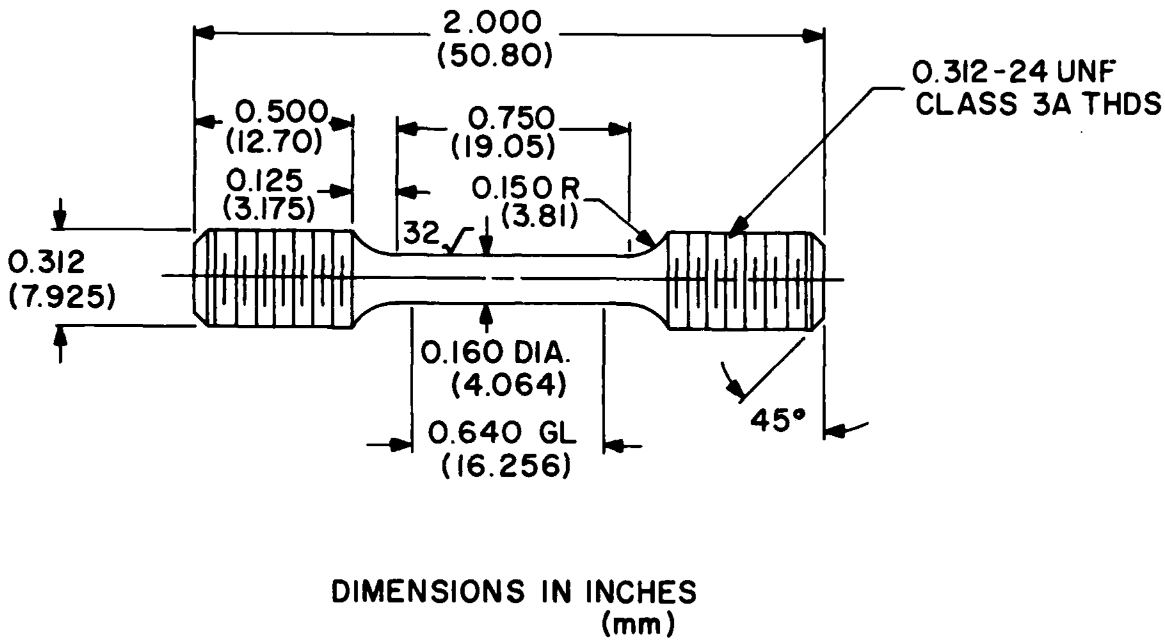
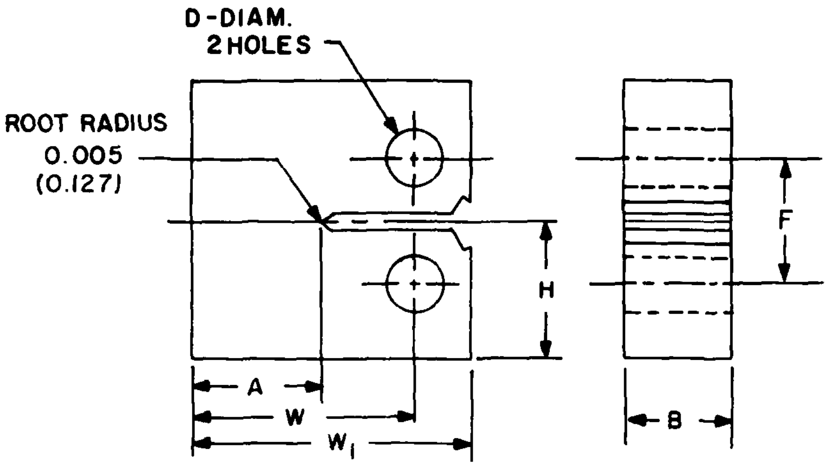


Figure 2. Specimen Configuration Used for Short-Transverse Grain Orientation Tensile Tests.



DIMENSIONS

APPLICATION	A	B	W	W_1	H	D	F
K_{IC}/K_{ISCC}	.915 (23.2)	.750 (19.1)	1.500 (38.1)	1.875 (47.6)	.900 (22.9)	.375 (9.5)	.824 (20.9)
$\frac{da}{dn}$	.915 (23.2)	.300 (7.6)	1.500 (38.1)	1.875 (47.6)	.900 (22.9)	.375 (9.5)	.824 (20.9)
K_{IC}	1.650 (41.9)	1.500 (38.1)	3.000 (76.2)	3.750 (95.3)	1.800 (45.7)	.630 (16.0)	1.650 (41.9)

DIMENSIONS: INCHES (mm)

Figure 3. Compact Type Specimen Configurations Used for Fracture Toughness (K_{IC}), Threshold for Stress Corrosion Cracking (K_{ISCC}), and Cyclic Loading Crack Growth (da/dN) Tests.

fracture toughness (K_{IC}), stress corrosion cracking (K_{ISCC}), and constant amplitude fatigue crack growth rate (da/dN) testing. The thickness, B, was 0.75 inch (19 mm) for the statically loaded stress corrosion cracking tests and for most of the fracture toughness tests. Since all of the initial fracture toughness tests loaded in the longitudinal grain direction were invalid by the ASTM E-399-78 test standard criteria, four additional larger fracture toughness specimens [B = 1.5 inches (36.7 mm)] were fabricated from the test plate remnant. A thickness, B, of 0.30 inch (7.6 mm) was used for all of the crack growth rate tests.

SECTION V
RESULTS AND DISCUSSION

Room temperature tensile test results are presented in Table 1. The alloy is a high strength 7000 series aluminum alloy directly comparable to alloy 7175, 7050, and 7475 in the T73 heat treated condition. There is very little variation in the ultimate and yield strength data obtained from the specimens with the three various grain orientations. The material's ductility as indicated by the elongation and reduction of area are approximately equal to the same 7000 series aluminum alloys listed above in the T73 heat treatment. The short transverse orientation tensile specimens demonstrated lower ductility than the other two grain orientations.

Room temperature and 250°F (121°C) fracture toughness test results are presented in Table 2. Those tests that are not valid do not meet the ASTM E-399-78 specimen thickness criteria which calls for a minimum thickness of approximately 0.84 inch (21 mm). Naturally, those specimens loaded in the longitudinal grain direction displayed the highest conditional toughness, K_Q, while those loaded in the short transverse grain direction have the lowest fracture toughness, K_{IC}, (valid by ASTM). Of the longitudinal specimen data those with the L-S orientation possess the highest K_Q test results at both room temperature and at 250°F (121°C).

TABLE 1

TENSILE PROPERTIES OF Al 7010-T73651
(All tests performed at 72°F (22°C))

Specimen No.	Grain Orientation	Ultimate Tensile Str. KSI	(MPa)	0.2% Yield Strength KSI	(MPa)	% Elong.	% R.A.
L1	Longitudinal	72.4	(499)	61.9	(426)	14.4*	43.0
L2	Longitudinal	72.8	(501)	65.1	(449)	13.4*	35.8
L3	Longitudinal	74.9	(516)	65.4	(450)	12.4*	38.0
L4	Longitudinal	74.5	(513)	65.2	(449)	11.2*	27.8
T1	Long-Transverse	73.5	(506)	62.6	(431)	10.5*	25.6
T2	Long-Transverse	73.7	(508)	62.5	(431)	12.0*	38.7
T3	Long-Transverse	73.0	(503)	62.2	(429)	12.6*	34.0
T4	Long-Transverse	74.5	(513)	64.2	(442)	12.5*	26.9
ST1	Short-Transverse	72.4	(499)	64.3	(443)	8.1**	19.5
ST2	Short-Transverse	73.4	(506)	66.2	(456)	7.7**	13.3
ST3	Short-Transverse	72.9	(502)	65.2	(449)	8.9**	10.6
ST4	Short-Transverse	74.7	(515)	64.1	(442)	7.0**	8.7

* Elongation in a 1 inch (25.4 mm) gage length.

** Elongation in a 0.5 inch (12.7 mm) gage length.

TABLE 2

FRACTURE TOUGHNESS TEST RESULTS FOR ALUMINUM 7010-T73651

Specimen No.	Orientation	Test Temperature (°F)	(°C)	K_Q KSI$\sqrt{in}$	(MPa$\sqrt{m}$)	ASTM Valid?
TL1	L-T	72	22	39.0	(42.9)	No
TL2	L-T	72	22	36.4	(40.0)	No
TL3	L-T	72	22	35.6	(39.1)	No
LT1	T-L	72	22	29.9	(32.9)	Yes
LT2	T-L	72	22	29.0	(31.9)	Yes
LT3	T-L	72	22	30.8	(33.8)	Yes
LS1	T-S	72	22	30.3	(32.3)	Yes
LS2	T-S	72	22	31.8	(34.9)	Yes
TS4	L-S	72	22	39.9	(43.9)	No
SL10	S-L	72	22	23.4	(25.7)	Yes
SL11	S-L	72	22	22.7	(24.9)	Yes
TL4	L-T	250	121	37.3	(41.1)	No
TL5	L-T	250	121	35.8	(39.3)	No
TL6	L-T	250	121	33.1	(36.4)	No
LT4	T-L	250	121	28.0	(30.8)	Yes
LT5	T-L	250	121	29.5	(32.4)	No
LT6	T-L	250	121	29.6	(32.5)	No
LS3	T-S	250	121	32.8	(36.0)	No
TS5	L-S	250	121	39.2	(43.1)	No
TS6	L-S	250	121	42.4	(46.6)	No
A1	L-T	72	22	37.8	(41.5)	Yes
A3	L-T	72	22	37.1	(40.8)	Yes
A2	L-T	250	121	38.0	(41.8)	Yes
A4	L-T	250	121	39.4	(43.3)	Yes

Generally the increase in environmental temperature from 72°F (22°C) to 250°F (121°C) had little effect on the material's conditional toughness, K_Q.

Because of the large number of invalid toughness data, primarily caused by insufficiant speciman thickness, four additional compact specimens (A1-A4) were fabricated from the remnant of the test plate but with thickness, B, equal to 1.50 inches (31.8 mm). Two of the specimens underwent tests at 72°F (22°C) and the other two were tested at 250°F (121°C). The results for all four of these tests are valid by the ASTM test standard and are presented at the bottom of Table 2.

Only two precracked short transverse (S-L) orientation compact type specimens were statically loaded in the 3.5 percent by weight sodium chloride corrosive solution. This loading orientation is the most sensitive to stress corrosion cracking for the following reasons: first, it has the lowest tensile strength; secondly, corrosion cracking is an intergranular phenomena, and with S-L specimen orientation the crack is moving in the longitudinal grain direction. These concomitant factors for this particular specimen orientation have a synergistic effect of accelerated corrosion crack propagation, thus causing the stress corrosion cracking sensitivity. The first specimen was loaded at 20 KSI$\sqrt{in}$ (22.0 MPa$\sqrt{m}$) which is 87 percent of the material's average room temperature fracture toughness (S-L orientation); the test specimen sustained the load for 885 hours when failure occurred. The second stress corrosion cracking test specimen was initially loaded at 17 KSI$\sqrt{in}$ (18.8 MPa$\sqrt{m}$), 73.8 percent of the material's average fracture toughness. The test was on line for 2,762 hours when it was terminated; specimen failure had not occurred. The fact that the threshold for corrosion cracking is in excess of 70 percent of the material's K_{IC}, indicated the material is insensitive to corrosion cracking in the type of environment investigated.

The room temperature fatigue crack growth test results are presented in Figures 4 to 6. Figure 4 presents the results for specimens loaded in the longitudinal grain direction (L-T and L-S); Figure 5 is a plot of the test data for specimens loaded in the

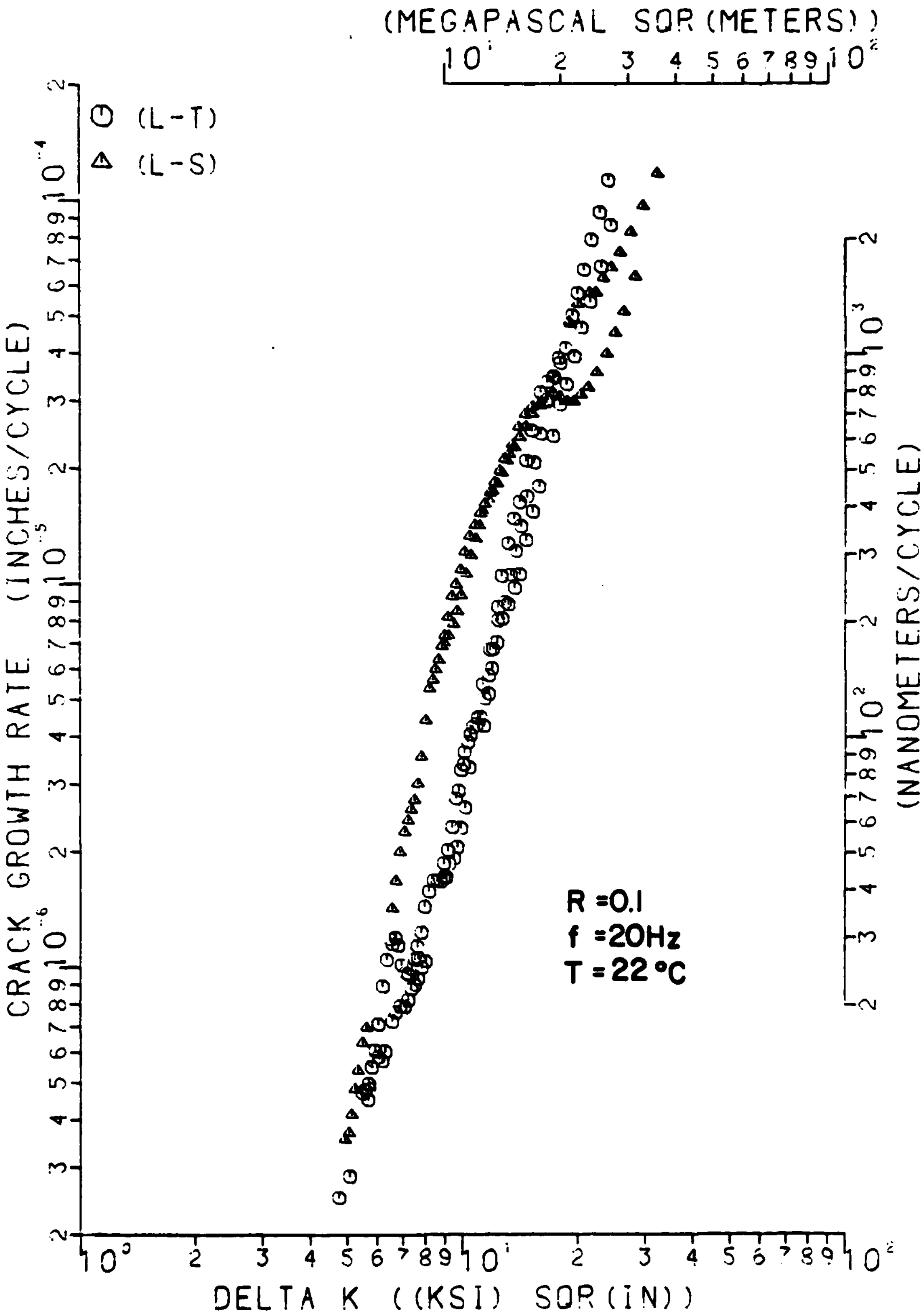


Figure 4. Constant Amplitude Loading Cyclic Crack Growth Test Results for CT Specimens Loaded in the Longitudinal Grain Direction at 72°F (22°C).

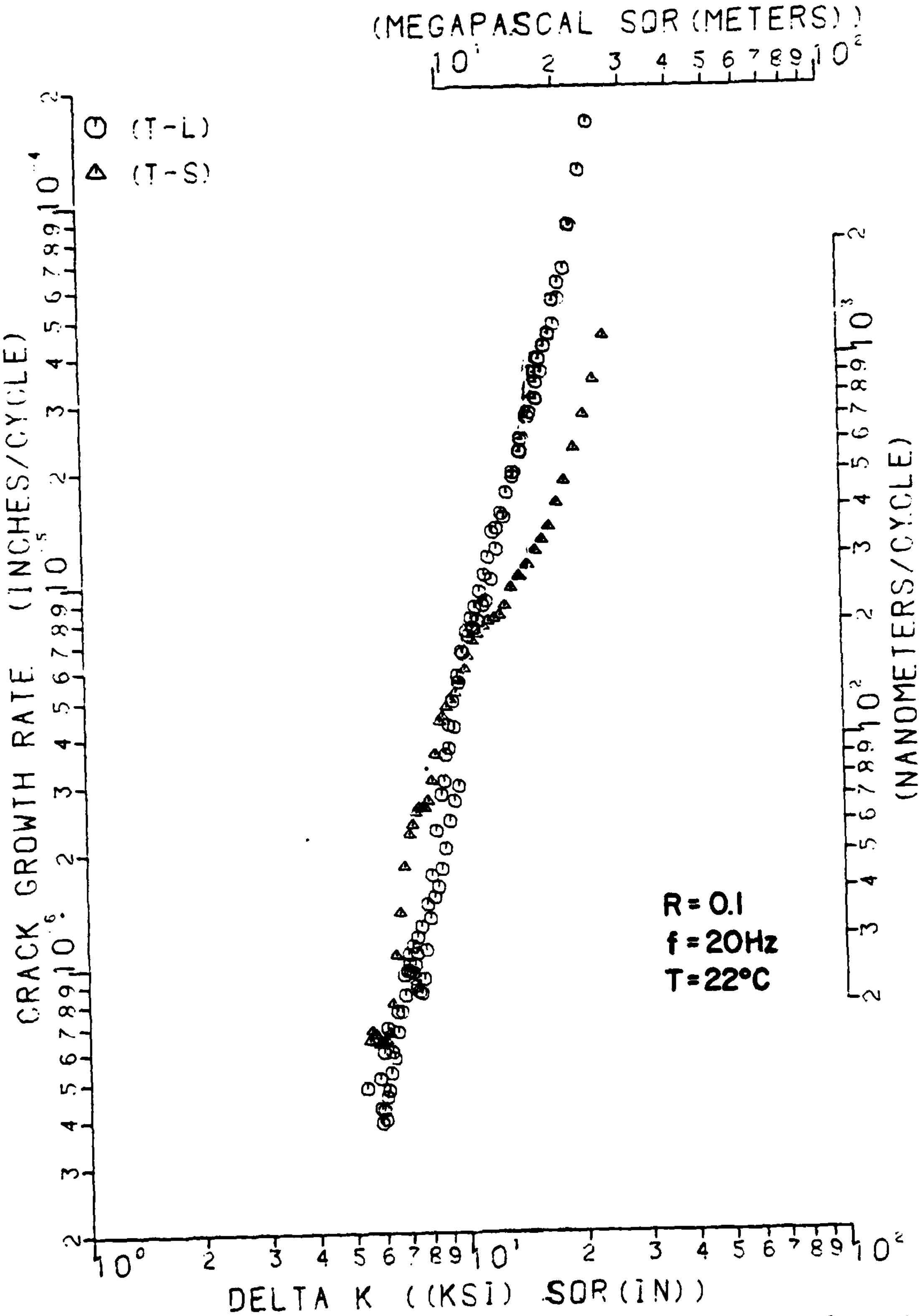


Figure 5. Constant Amplitude Loading Cyclic Crack Growth Test Results for CT Specimens Loaded in the Long-Transverse Grain Direction at 72°F (22°C).

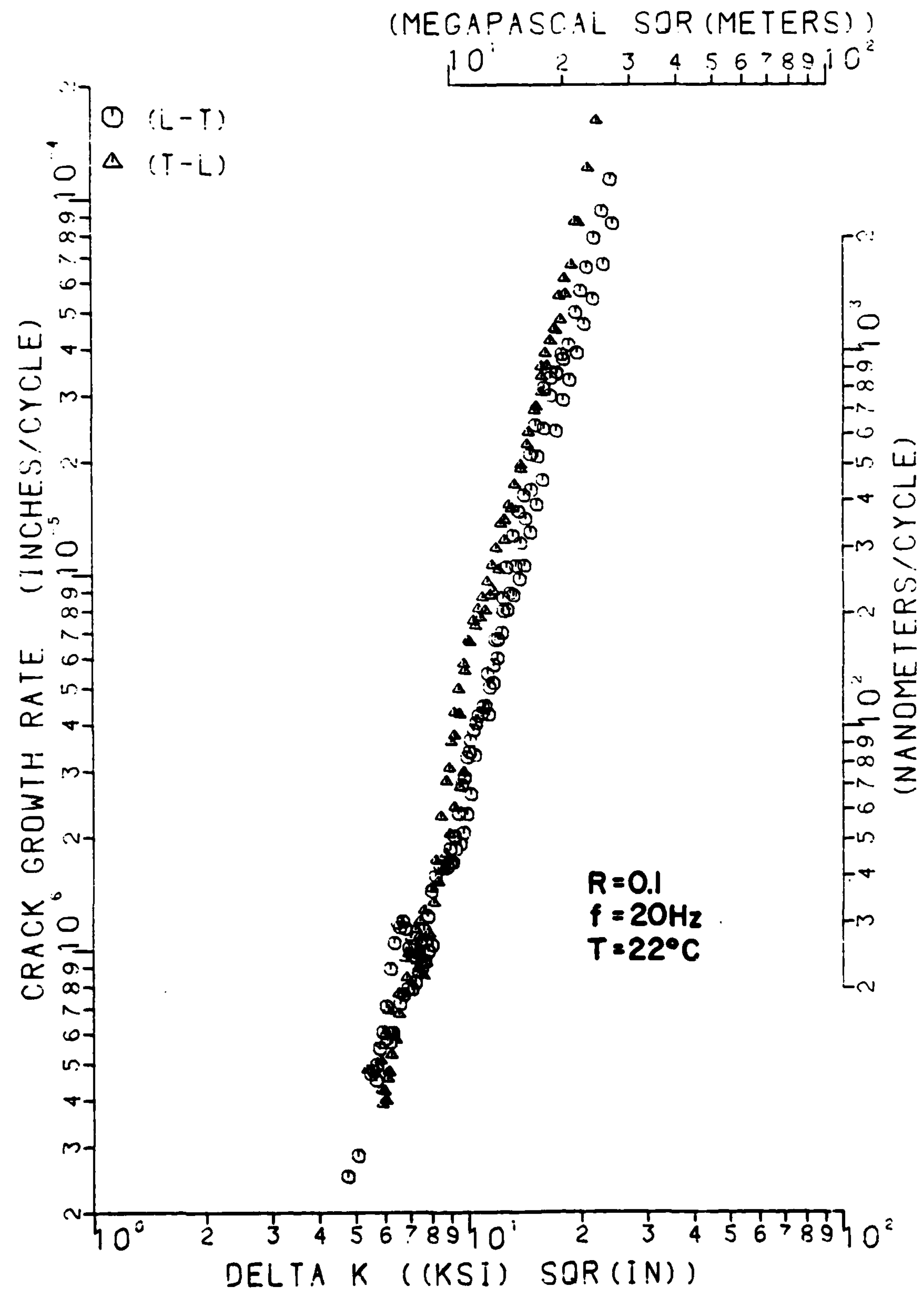


Figure 6. **Constant Amplitude Loading Cyclic Crack Growth Test Results for L-T and T-L Oriented CT Specimens at 72°F (22°C).**

long-transverse grain direction (T-L and T-S). There is much more scatter in the data derived from specimens where the crack propagated in the short-transverse grain direction compared to the data representing test specimens with the crack moving in the longitudinal or the long-transverse grain directions. In both figures (see Figure 4 and 5) the specimens with L-S and T-S orientations have wider scatter bands and cross over the data derived from specimens with L-T or T-L grain orientations which plotted in a narrow, well defined data scatter band. This point is better illustrated in Figure 6 where the same 72°F (22°C) L-T and T-L specimen orientation data is replotted together. Only at the slower crack growth rate do the data sets plot on top of each other. For most of the data for a constant stress intensity range the material loaded in the longitudinal grain direction was more crack growth resistant.

The room temperature crack growth test data in the L-T orientation was replotted in Figures 7 and 8 with Reference[1-3] test data. Figure 7 presents test data for aluminum alloy 7050-T73651 which was reported in Reference 1. The chemical composition of this alloy is similar to that of the test alloy 7010. Alloy 7050 test data were generated with a loading frequency of 25 Hz where the room temperature test data for this program were run at 20 Hz; all other test parameters were identical. The alloy 7050 data plot in the same scatter band as the alloy 7010 test data.

Figure 8 presents additional Reference[2,3] test data for alloy 7475 and 7010, again with the same 72°F (22°C), L-T orientation, alloy 7010 test data. Alloy 7475-T7351 is a high strength, high toughness and corrosion resistant high purity alloy. Test conditions used to generate the alloy 7475-T7351 Reference[2] data were identical to those used in this program. The Reference[2] data plots directly over this program's test data. In addition, the solid line in Figure 8 represents Reference[3] data derived from a 4.0 inch (102 mm) thick plate of alloy 7010-T73651 produced and tested by Alcan Plate Limited. The Alcan data were generated using a center cracked panel and a loading ratio, R, equal to 0.125. The line fitted through the Alcan data crosses over the data produced in this program.

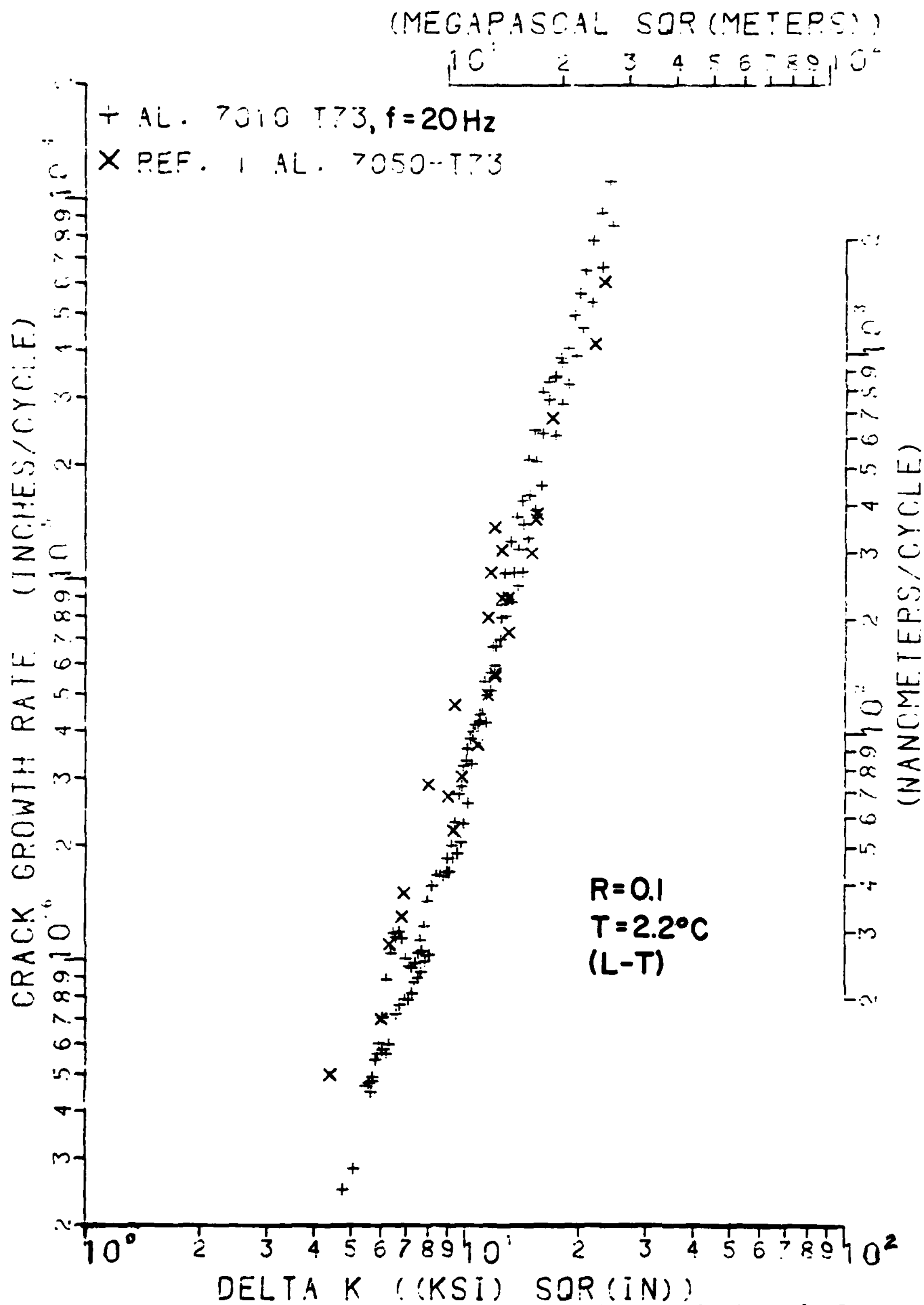


Figure 7. Constant Amplitude Loading Cyclic Crack Growth Test Results Plotted Along with Room Temperature Aluminum Alloy 7050-T73 Test Data.

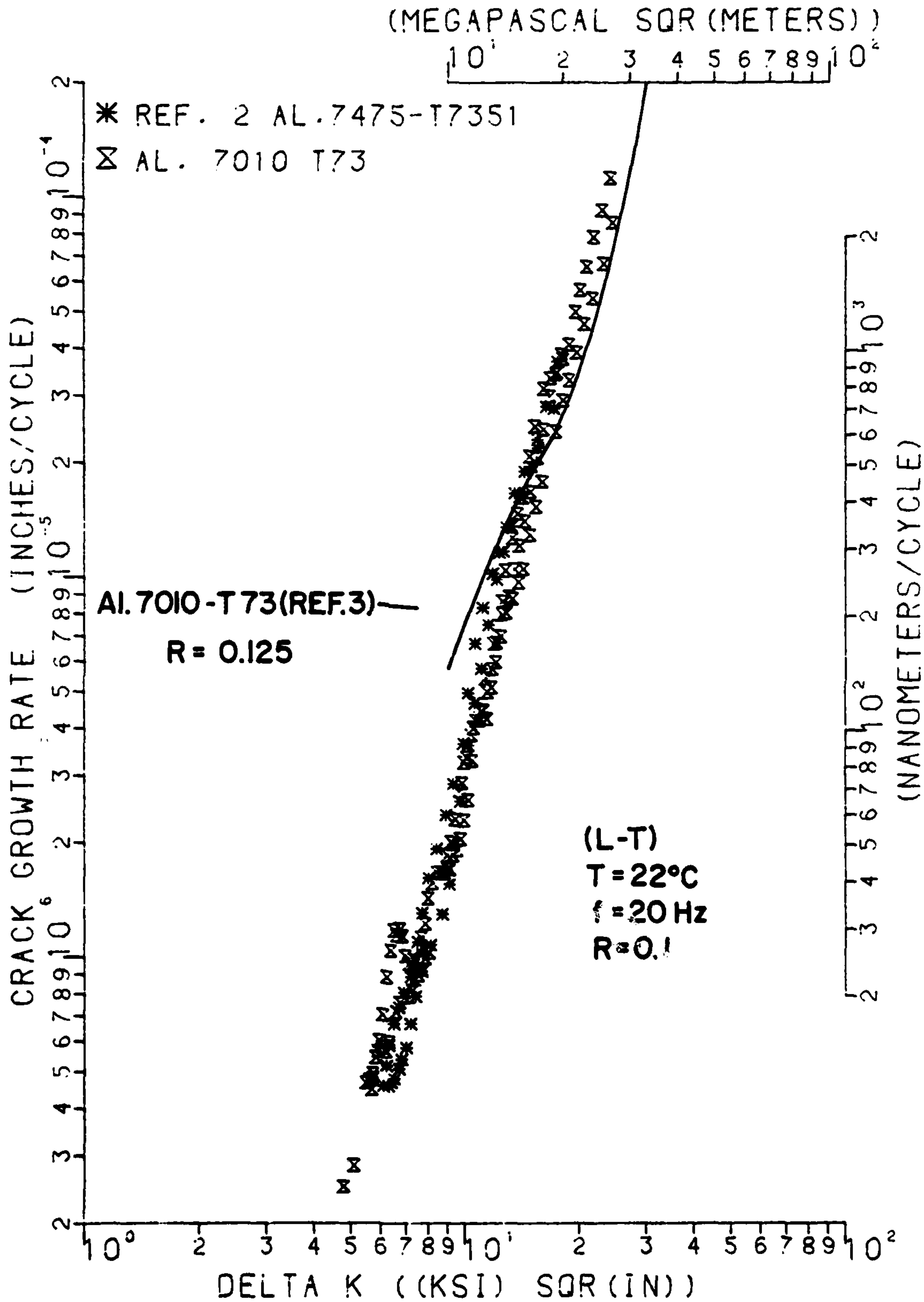


Figure 8. Constant Amplitude Loading Cyclic Crack Growth Test Results Plotted Along with Reference Room Temperature Aluminum Alloys 7475-T7351 and 7010-T73 Test Data.

The 250°F (121°C) crack growth test results are presented in Figures 9 and 10. All of the elevated temperature crack growth tests used a loading frequency of 25 Hz. Figure 9 is a plot of the data obtained from the specimens loaded in the longitudinal grain direction (L-T and L-S), and Figure 10 presents the data for specimens loaded in the long-transverse grain direction (T-L and T-S). All of the data plots in a narrow scatter band. For the elevated temperature data associated with the crack moving in the short-transverse grain direction (L-S and T-S) there is not near as wide of a data scatter band as occurred in the data generated at 72°F (22°C) for these same two specimen grain orientations. For a constant stress intensity range, ΔK, the crack growth rate at 250°F (121°C) is two to five times faster than that at 72°F (22°C). This point is better illustrated in Figure 11 where the 72°F (22°C), 250°F (121°C), and 350°F (176°C) test results, for (L-T) specimen orientation, are presented together. There is a well defined shift between the crack growth data generated at 72°F (22°C) and that conducted at 250°F (121°C). The data obtained from the single crack growth specimen tested at 350°F (176°C) plots on the left side of the 250°F (121°C) data scatter band and for a constant stress intensity range represents approximately a 30-50 percent increase in the crack growth rate over that existing at 250°F (121°C).

SECTION VI
CONCLUSIONS

1. The test plate was a high purity aluminum alloy with very low Si and Fe content.
2. The alloy has high strength, high toughness, and good ductility comparable to alloys 7050-T73, 7175-T73, and 7475-T73.
3. The increase in test temperature from 72°F (22°C) to 250°F (121°C) had little effect on the conditional toughness, K_Q, test results.
4. The material is insensitive to stress corrosion cracking in a 3.5 percent by weight NaCl solution.

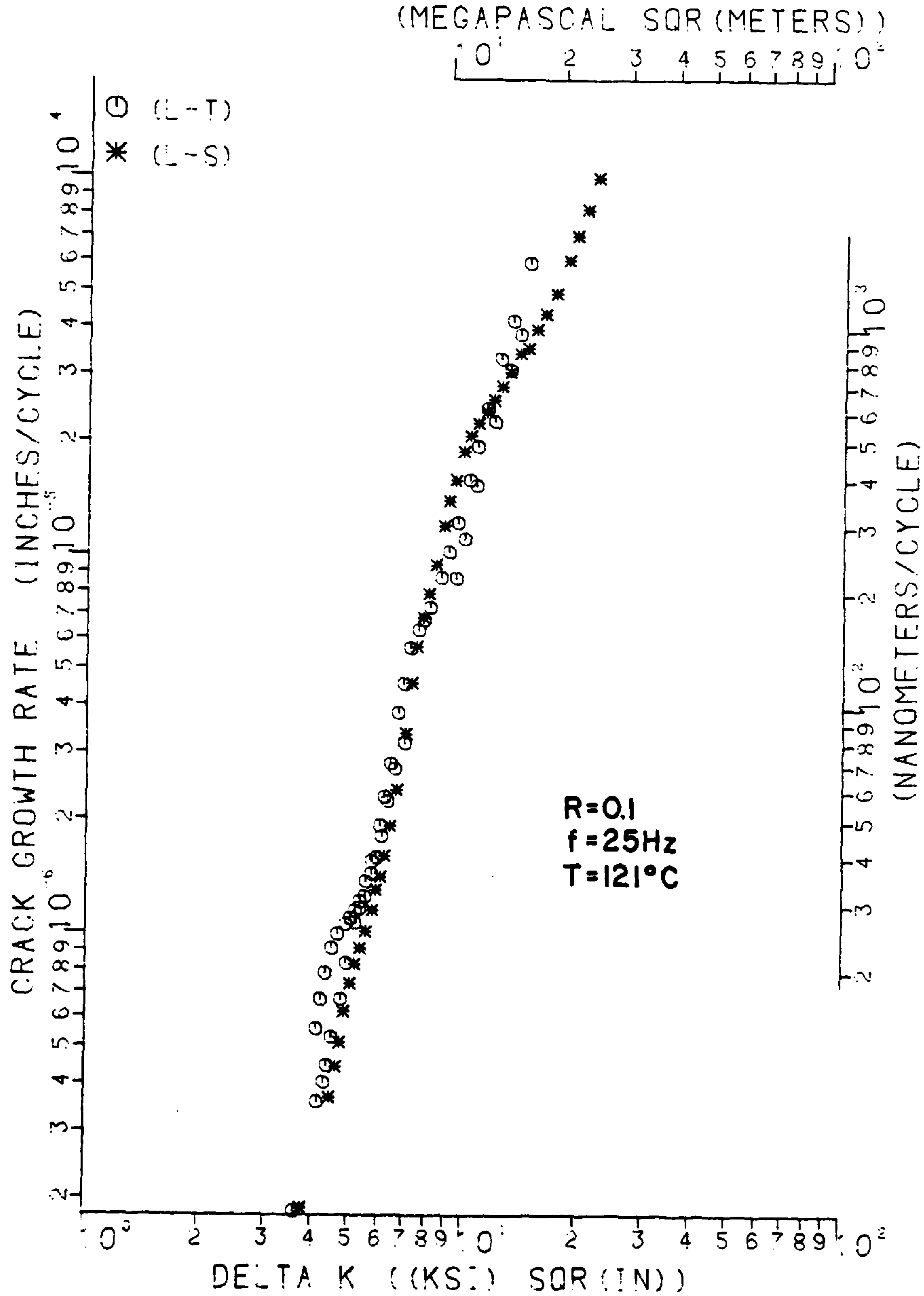


Figure 9. Constant Amplitude Loading Cyclic Crack Growth Test Results for Longitudinal Grain Loaded CT Specimens at 250°F (121°C).

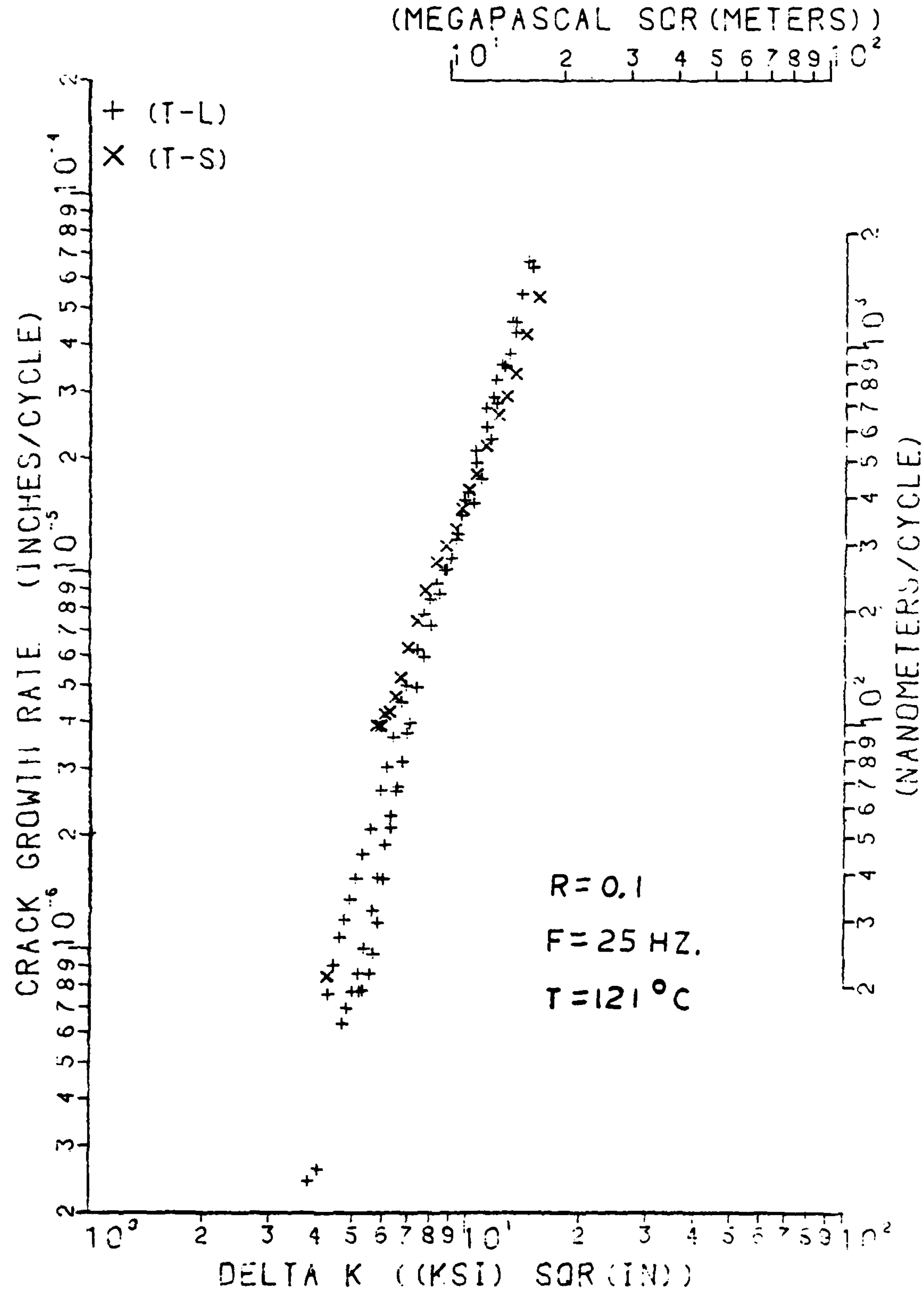


Figure 10. Constant Amplitude Loading Cyclic Crack Crowth Test Results for Long-Transverse Grain Loaded CT Specimens at 250°F (121°C).

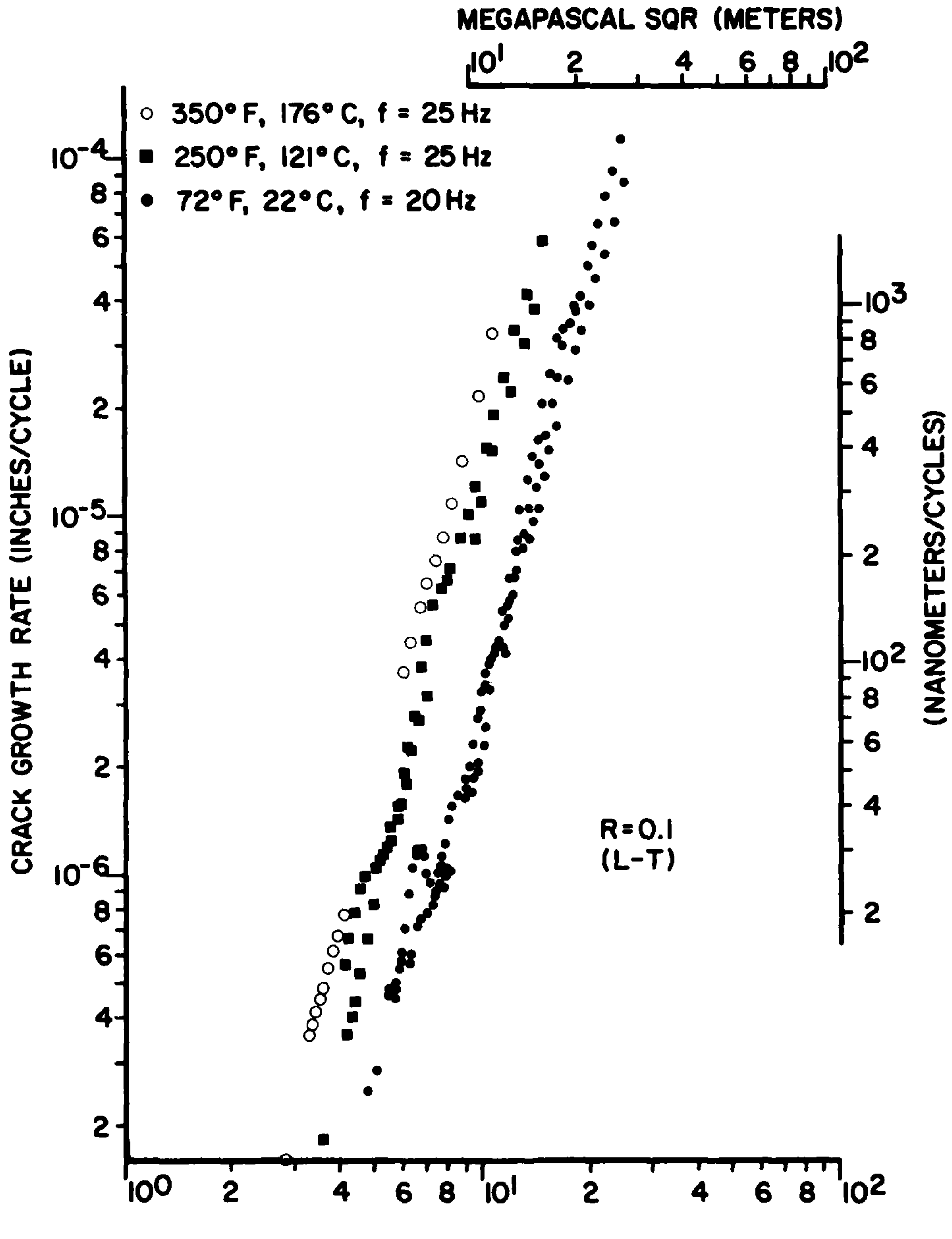


Figure 11. Constant Amplitude Loading Cyclic Crack Growth Test Results for L-T Oriented CT Specimens at 22°C, 121°C, and 176°C.

5. The test material's room temperature constant load amplitude crack growth resistance is comparable to other high strength, high toughness, 7000 series aluminum alloys: 7050, 7175, and 7475.

6. There was a large increase in the constant amplitude crack growth rate when the test temperature was increased from 72°F (22°C) to 250°F (121°C).

7. There is a subtle increase in the crack growth rate when the test temperature was increased from 250°F (121°C) to 350°F (177°C).

REFERENCES

1. Jones, R. E. and Fudge, K. A., Engineering Design Data for Aluminum Alloy 7050-T73651 Plate, University of Dayton Research Institute, Technical Report AFML-TR-73-269, August 1973.

2. Cervay, R. R., Static and Dynamic Fracture Properties for Aluminum Alloy 7475-T651 and T7351, University of Dayton Research Institute, Technical Report AFML-TR-75-20, April 1975.

3. Harris, J. G., 7010 Plate, Alcan Plate Limited, Technical Department Report, January 1978.

☆U.S.Government Printing Office: 1980 — 657-084/187